

CEMENT AND LIME MANUFACTURE

XXVI. No. 6

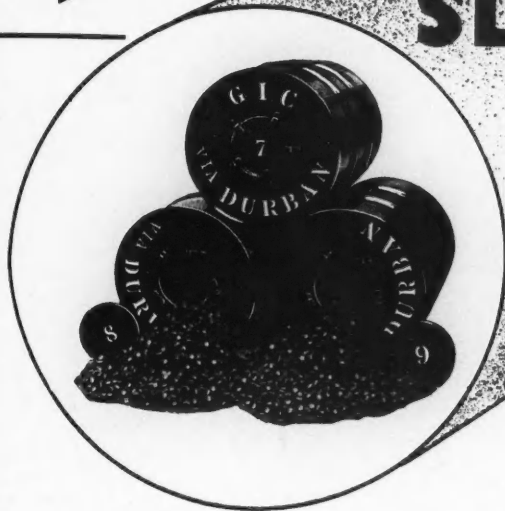
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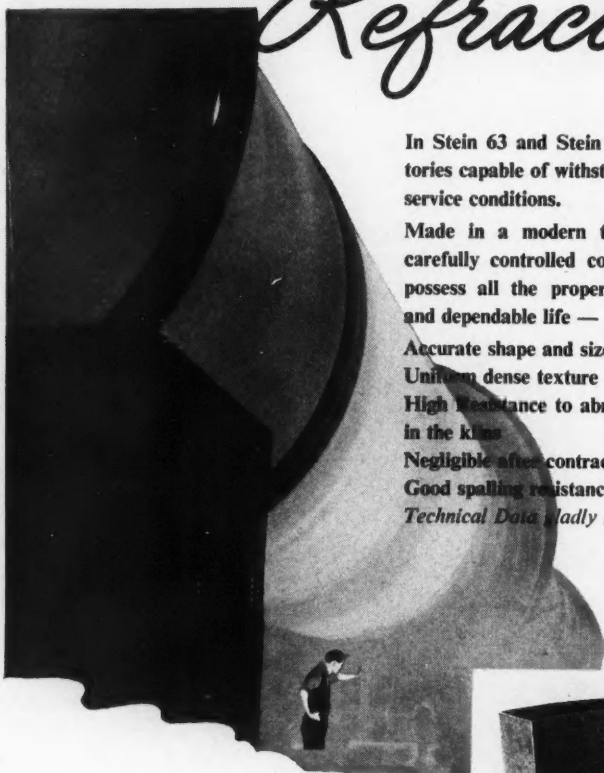
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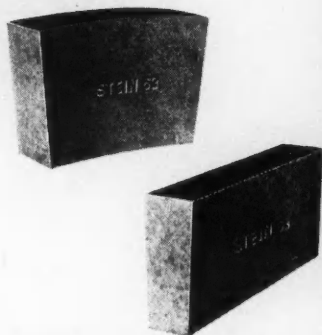
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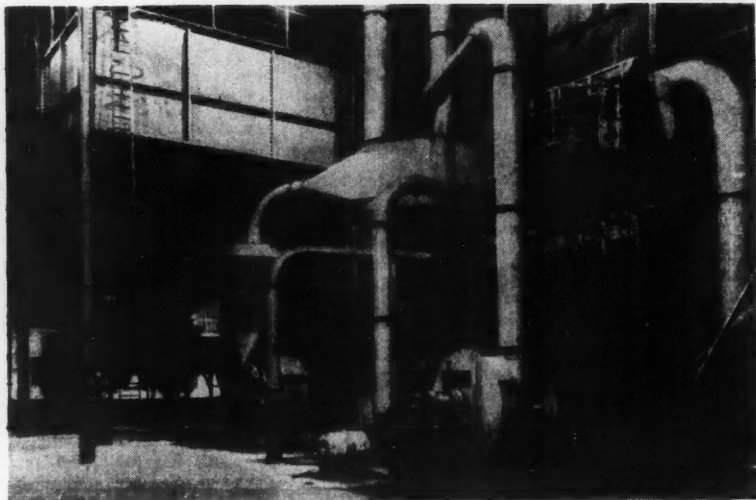
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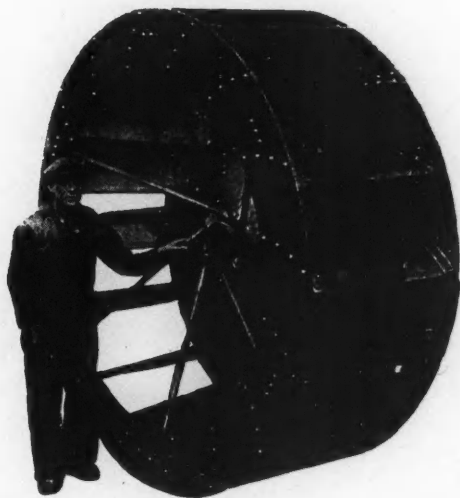
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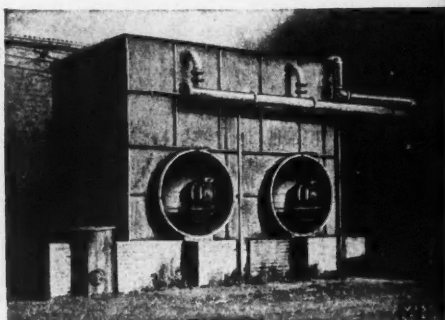
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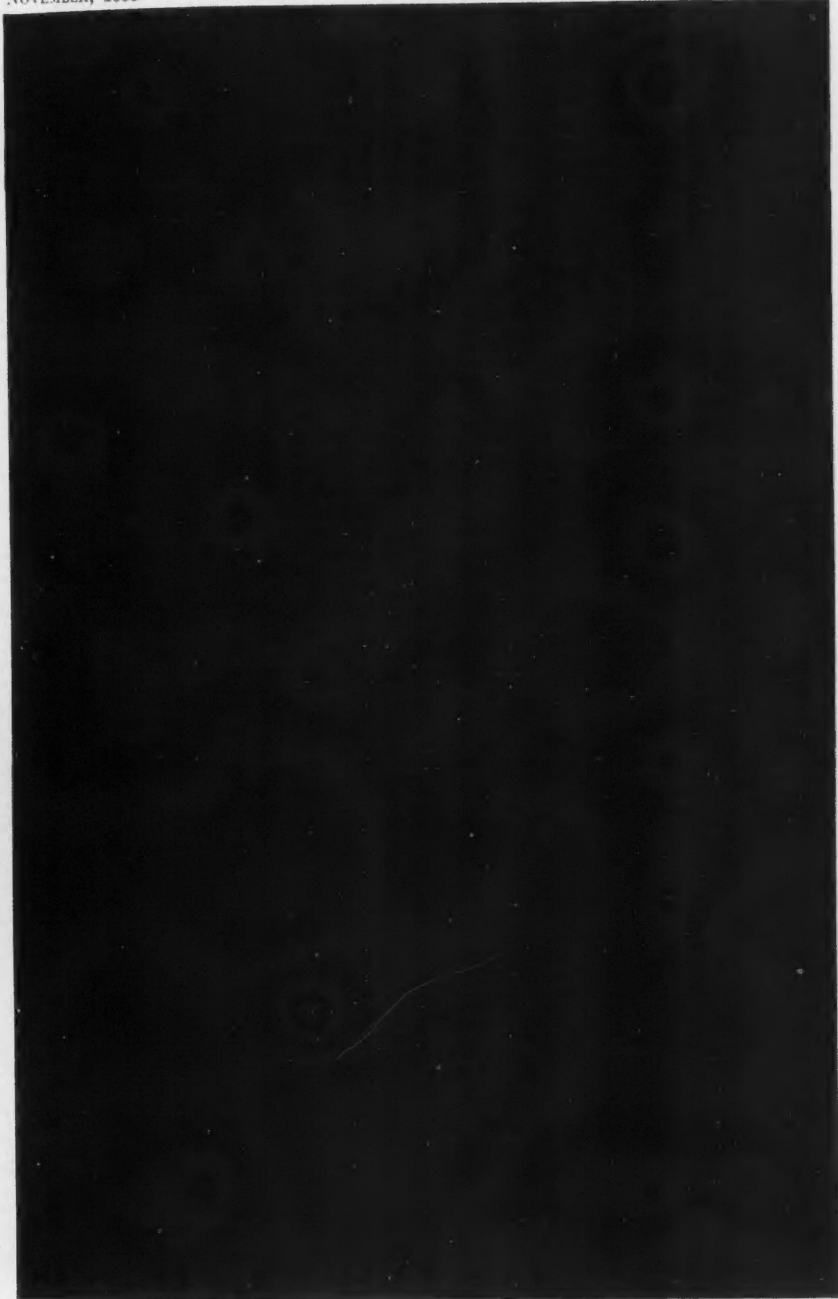
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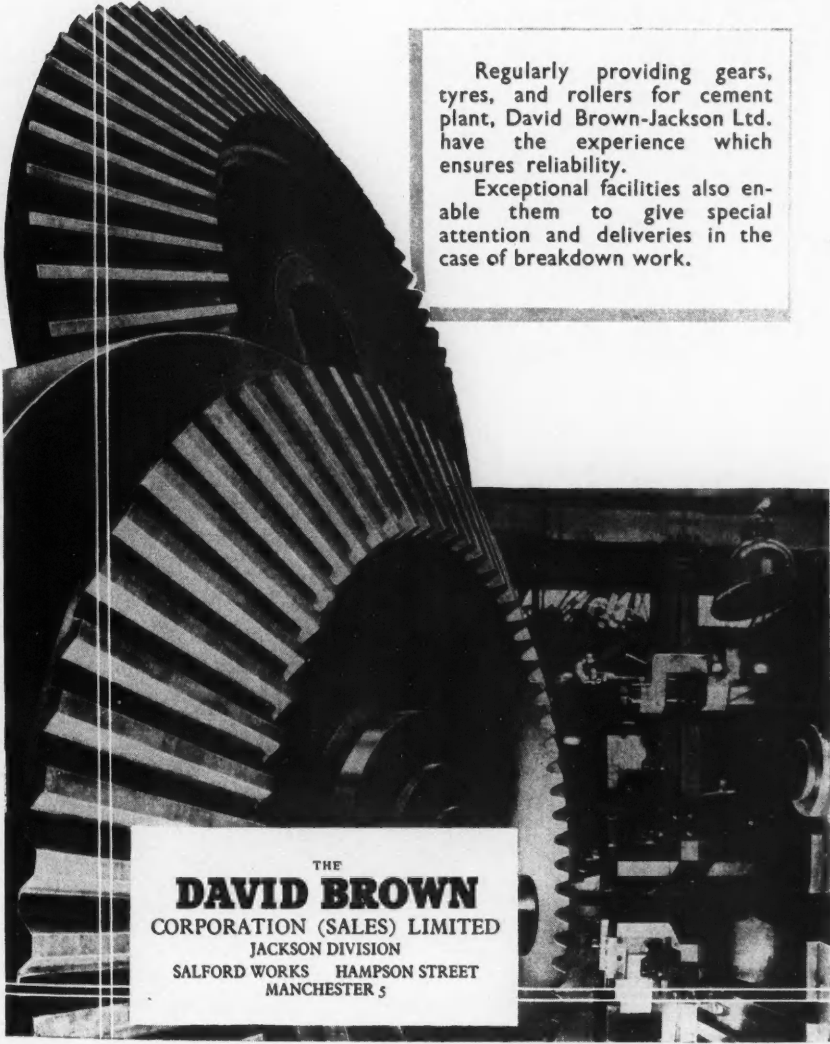
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NOVEMBER, 1953

Research on Cement, Lime and Plaster.

THE following notes are abstracted from the Report of the Building Research Board for the year 1952 (H.M. Stationery Office. Price 3s. 6d.).

CEMENT AND SILICATE CHEMISTRY.—A simplified method of thermal analysis, requiring very small quantities of material, has been adopted for melting-point determinations. This method is being used in conjunction with the normal quenching method to assist in the revision of the system lime-alumina, and in preliminary studies of sections in the system $\text{CaO-MgO-Al}_2\text{O}_3\text{-SiO}_2$ that are of importance in high-alumina cement and blastfurnace slag. The Verneuil flame-fusion method has been used to synthesise single crystals of $\text{CaO} \cdot 2\text{Al}_2\text{O}_3$, and it is hoped in this way to prepare further single crystals and also pure compounds that have too high a melting point for the platinum furnaces.

A single-crystal X-ray study of the "unstable $5\text{CaO} \cdot 3\text{Al}_2\text{O}_3$ " of high-alumina cement has shown it to belong to one of the space groups $\text{P}_{21}2_12$ or Pmmn . Powdered X-ray examination of the magnetic fraction of Portland cement has shown that the composition of the iron-bearing phase is variable and is represented by points in the solid solution series $2\text{CaO} \cdot \text{Fe}_2\text{O}_3$ — $6\text{CaO} \cdot 2\text{Al}_2\text{O}_3 \cdot \text{Fe}_2\text{O}_3$. Apparatus has been built for the study of the effect of ultrasonic vibration on the rate of hydration of cement. During the year further investigations of the naturally-occurring hydrated calcium silicates have been made and, in particular, their dehydration has been studied. Using a special method of separating the hydrated portion from set cement, it has been possible to show that the calcium silicate hydrate found in synthetic studies is among the products of hydration. The same compound has been detected in a direct examination of a hydrated slag cement.

CEMENT TESTING.—During the year the Station participated in cement tests with the International Committee of the Union of Laboratories for Testing and

Research on Materials and Structures (Reunion des Laboratoires d'Essais et de Recherches sur les Matériaux et les Constructions). The tests, which were carried out in accordance with methods agreed to by the Committee, included transverse and compressive strength tests on hand compacted mortars. The variability of the results between the eighteen co-operating laboratories was similar to that previously experienced in this country with hand-compacted mortars and much higher than that found with the vibrated mortar compression test, now adopted as the British Standard method. The average coefficients of variation between laboratory tests were as follows: Tensile test (hand-compacted)—Reunion tests 9.5 per cent.; British tests 13.1 per cent. Transverse test (hand-compacted)—Reunion tests 10.3; British tests not stated. Compressive tests (hand-compacted)—Reunion tests, 15.9 per cent.; British tests 16.1 per cent. Compressive tests (vibrated according to British Standard No. 12)—British tests 4.4 per cent.; no Reunion tests.

It has been proposed by the Cement Makers' Federation that the quality of cement might be evaluated by tests on concrete specimens. Tests have been made in co-operation with three other laboratories, and further tests are to be made in co-operation with more laboratories.

HYDRAULIC LIME.—The reliability of certain methods tentatively proposed for determining the proportion of reactive cementitious compounds in hydraulic lime is being investigated. The determination of reactive aluminates by interaction with calcium sulphate to form calcium sulphoaluminate has been found to be inaccurate, because calcium sulphate reacts also with inert compounds of alumina and with unburnt rock. Extraction of aluminates with sodium carbonate solution was found equally unsuitable. Silica can be liberated from reactive silicates by treatment with acid under controlled conditions and can be quantitatively determined if it can be kept in solution to separate it from the residue; it tends, however, to be carried down in association with the precipitate of alumina liberated from the aluminates present. The addition of sodium tartrate keeps the alumina in solution and so prevents this partial precipitation of silica. Both silica and alumina can then be separately determined in the filtrate. The method appears to be reliable for the determination of reactive silicates. Whether the alumina in the filtrate provides an accurate measure of the reactive aluminates remains to be investigated.

CALCIUM SULPHATE PLASTERS.—The adhesion of gypsum plasters to films of regenerated cellulose has been examined, as relevant to the study of the adhesion of plaster to plasterboard. Hemihydrate plasters are found to adhere to these as strongly as to plasterboard, whereas anhydrous plasters fail to adhere at all. Since the surface of the cellulose film is smooth and virtually non-porous, adhesion is likely to be specific rather than mechanical. Why there is so much difference between the two types of plaster is not yet known. The marked influence of a small proportion of lime in reducing the adhesion of anhydrous plaster to plasterboard, which had previously been shown to be associated with the presence of a thin layer of unset plaster at the interface, has been traced to an effect of the

resin used in the manufacture of the paper facing; in the presence of lime this resin inhibits the setting of anhydrous plasters.

Measurements of the dimensional changes associated with the wetting and drying of gypsum plasters have been made under various conditions. The wetting-expansion and drying-shrinkage, though commonly regarded as too small to be of practical significance, are none the less appreciable. Fully-hydrated specimens prepared from pure plaster of Paris, using 50 per cent. by weight of mixing water, contract by 0.015 to 0.025 per cent. when dried from the saturated condition to a condition of equilibrium with air at 65 per cent. relative humidity, and to a rather less extent if the proportion of mixing water is increased. When brought to equilibrium with air, first at 40 per cent. and then at 90 per cent. relative humidity, there is an expansion of 0.005 to 0.015 per cent. This expansion is not entirely reversible, for continued alternation between high and low humidities over this range causes a slow but progressive shrinkage. This, in specimens prepared with 50 per cent. and 150 per cent. of mixing water and subjected to weekly cycles over a period of 18 months, has amounted to 0.015 per cent. and 0.02 per cent. respectively. In contrast to this, immersion of freshly-prepared specimens in water or saturated gypsum solution causes an irreversible expansion, which in three months may amount to as much as 0.5 per cent. This expansion may be caused by the growth of the larger crystals at the expense of the smaller ones of higher solubility, but, if so, it is difficult to understand why alternate gain and loss of adsorbed moisture in air of high and low humidity should not have a similar effect.

The moisture expansion of fully-set plaster must be distinguished from the expansion that occurs under moist conditions if part of the plaster escapes hydration in the original setting of the mixture. Two complaints of abnormal expansion of gypsum plasterboard reported in the course of the year, one of them from outside the United Kingdom, were found to be associated with the presence of plaster of Paris in the plaster core. This may be the result of incomplete hydration of an unsuitable grade of plaster, or plaster of Paris may have been reformed by overheating the board in the drying stage of manufacture. Again, when anhydrous plasters used as finishing coats for plastered walls show "delayed expansion," leading to bulging and cracking of the finishing coat, the expansion is attributed to the hydration of plaster that has not been fully hydrated in the plastering operation. Measurements have shown that the overall setting-expansion of plaster can be much greater when hydration is interrupted by premature drying than when hydration is allowed to proceed without interruption. Under comparable conditions, expansion is greater if the second stage of hydration is brought about by liquid water than if it proceeds in air of high humidity. This suggests that defects associated with delayed expansion are more likely to occur if circumstances conduce to rain-penetration through the wall or to excessive condensation than if the plaster is exposed simply to the normal fluctuations in the humidity of the room in which it is used.

Transporting Loose Cement by Ship.

THE illustrations on page 81 show a motor ship which has been adapted in Germany for the transport of loose cement. The pumps for unloading the cement are installed in the ship. There are 26 containers each with a capacity of 12 cu. yd. The containers have a filling hatch at the top, and the bottom, which is funnel-shape (*Fig. 2*), is inclined at 55 deg. to the horizontal. There are two compressors each of 1½ cu. yd. capacity per minute and three compressors of 4 cu. yd. capacity per minute. Also, each container is fitted with a pump, and these are driven by a 90-h.p. Diesel engine. The ship (*Fig. 1*) is 110 ft. long by 21 ft. wide, and is propelled by a 280-h.p. Diesel engine.

The containers are filled by pipelines from silos on a quay or, where these are not available, from funnel-shaped vessels lifted by a crane; these vessels have a capacity of 5 tons each, and if twelve are in use the containers in the ship can be filled at a rate of 30 to 40 tons per hour.

The containers in the ship are emptied by blowing the cement through a pipe to a silo on shore.

The ship illustrated, which was fitted out by Klinger KG., of Wiresbaden-Dotzheim, is used for transporting cement on the Dortmund-Ems canal. The foregoing notes are from "Zement-Kalk-Gips."

A New Cement Laboratory in U.S.A.

A LABORATORY for research in the production of cement and the development and testing of concrete products has recently been built for the Ideal Cement Co. at Boettcher, Colo., U.S.A., and was described in the U.S.A. journal "Rock Products" for August, 1953.

Accommodation for physical, chemical, and petrographical testing of cement and of the raw materials for the manufacture of cement, lightweight aggregates, and concrete is contained in a two-story building with a floor area of 8300 sq. ft. A complete pilot plant for the manufacture of cement is in adjacent buildings. The equipment includes two kilns, one 12 ft. by 1 ft. 5 in. and one 30 ft. by 3 ft., with automatic controls and recording instruments. In addition there are administrative and drawing offices, a library, and a machine shop.

New Cement Works in Tangier.

A NEW cement works has been built in Tangier by S.A. Cementos Tanger and production commenced early this year. The capacity of the works is stated to be 50,000 tons a year which could be increased to 100,000 tons a year. The estimated consumption of cement in Tangier is 50,000 tons a year, all of which is imported at a cost of about £370,000. The new company hopes to produce all the cement required for use locally and to have a surplus for export.

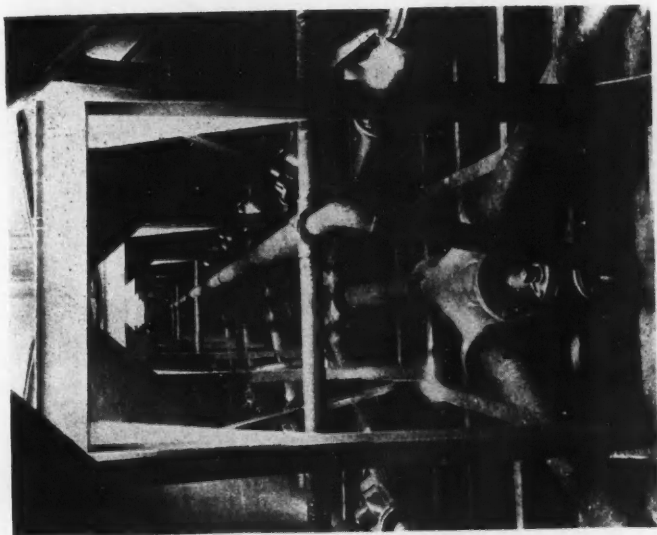


Fig. 2.—Conveying System under Containers.

(See page 80.)

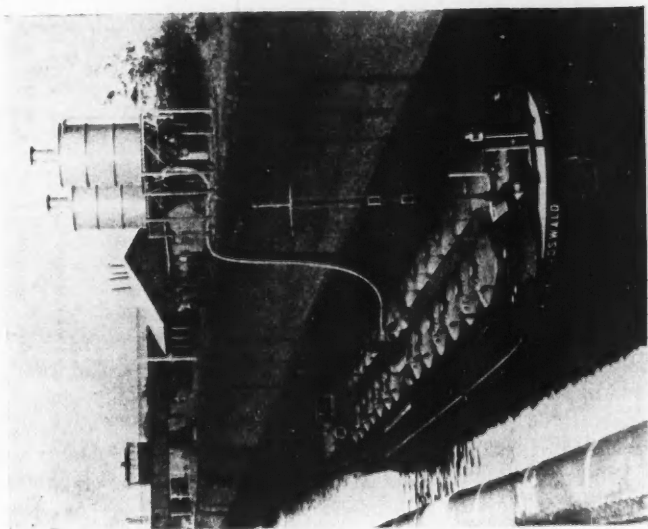


Fig. 1.—A Ship for Loose Cement.

A Single-kiln Cement Plant in the U.S.A.

A WET-PROCESS plant recently completed at Jamesville, N.Y., U.S.A., for the Alpha Portland Cement Co., was designed for a daily production of about 370 tons; it is producing about 400 tons daily, and employs 70 men. The arrangement of the plant is shown in *Figs. 1 and 2*, and a flow-sheet in *Fig. 3*. Types I, IA, and II cements as specified by the American Society for Testing Materials, and a special cement for the New York State Highway Department, are produced.

The arrangement of the storage compartments and feed bins is shown in *Figs. 4 and 5*. Concrete bins, which serve as feed hoppers for the separate raw

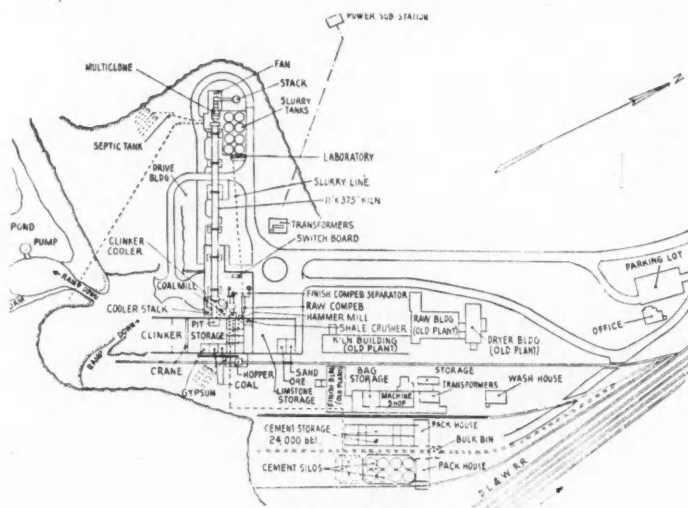


Fig. 1.—Plan.

materials, are in a single row transversely to the longer axis of the building and in line with the axis of the grinding mill in the adjoining building so that one conveyor delivers proportioned materials to the mill. Separate feeders deliver each material from overhead bins on to this conveyor. A similar arrangement conveys clinker and gypsum to the finish grinding mill, which is parallel to the raw mill in the same building. The kiln is covered at the feed end, at the drive, and at the firing end and in an extension of the mill building. All the grinding equipment, including the coal mill, are in one building at the firing end. Beneath the feed-conveyor floor and extending under the grinding mills is a store for spare parts, kiln linings and other supplies. Under the slurry silos are a laboratory and the pumps for blending slurry and the compressors. The kiln is on reinforced concrete arches, the space under the arches being used for stores, repair shops, and other purposes.

Raw Materials.

The store is 280 ft. long by 80 ft. wide. Materials are conveyed from the receiving hoppers to the storage compartments by an 8½-ton electric gantry crane with a 3 cu. yd. clam-shell bucket. The hopper for uncrushed shale is over a 24-in. by 40-in. single-roll crusher, driven at 35 r.p.m. by a 75-h.p. motor, and reduced to minus 2 in. at a rate of 50 tons per hour. The crushed shale is conveyed to the store by a 36-in. by 10-ft. oscillating conveyor consisting of a horizontal steel trough supported by coil springs and operating at the natural frequency of the springs, the theory being that the energy required to convey the materials is stored in the springs and is returned at every stroke, similar to the action of a fly-wheel. The conveyors are driven by 2-h.p. and 3-h.p. motors.

GRINDING RAW MATERIALS.—The proportioned raw materials are delivered by a 24-in. by 51-ft. oscillating conveyor to a hammermill for reduction to minus ¾ in.

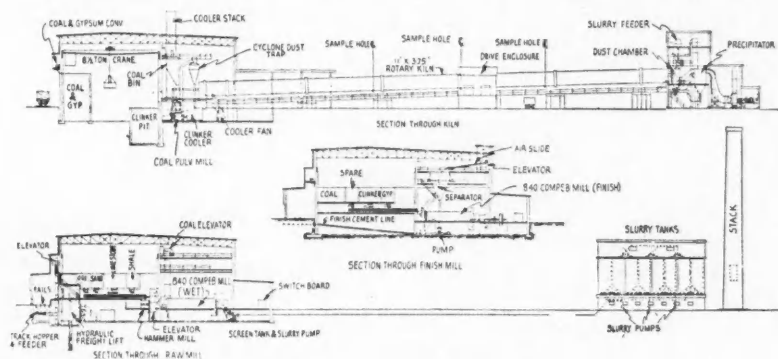


Fig. 2.—Sectional Elevations.

before being passed to the raw mill. Limestone is fed on to the conveyor by a 30-in. reciprocating feeder with constant-weight feeders and adjustable-speed drives to regulate the flow of materials on to the common conveyor. The hammermill is driven by a 75-h.p. motor and has a capacity of 60 tons per hour of minus ¾-in. material. An elevator delivers the material to the raw-mill, water being delivered to the spout through a hand valve. The material is ground at the rate of 38 tons per hour, to a fineness such that 90 per cent. passes a 200-mesh sieve, in an 8-ft. by 40-ft. 3-compartment mill driven at 19.85 r.p.m. by a 1000-h.p. synchronous motor through a magnetic clutch. The charge consists of 51,000 lb. of 4-in. forged steel balls in the first compartment, 75,000 lb. of 1½-in. balls in the second compartment, and 70,000 lb. of ¾-in. balls in the finishing compartment. The grinding is in open circuit except that oversize particles passing through the mill are returned to the feed spout. These pieces, ¼ in. to ¾ in., are intercepted by a 4-ft. by 5-ft. single-deck screen which rejects plus ¼-in. material into a hopper where water is added and the mixture is pumped through a 1-in. pipe into the mill.

Slurry is pumped by a 3-in. pump through a pipe 500 ft. long to the tanks near the feed-end of the kiln.

BLENDING.—Eight reinforced concrete slurry tanks, 20 ft. diameter by 31 ft. high, are arranged in two rows of four. The working capacity of each is sufficient for about 147 tons of clinker, which is sufficient for about three days' operation of the kiln. Above the tanks are three distributing boxes. One supplies the four tanks nearest to the raw mill; the second supplies the four tanks from which the corrected slurry is drawn for the kiln feed. The third distributing box, not generally used, permits delivery of slurry from the mill to two of the kiln-feed tanks. There are two 3-in. slurry pumps for blending, and a third 3-in. pump delivers corrected slurry from two kiln-feed tanks to a 54-in., 12-bucket, ferris-wheel over the kiln. Overflow from the feeder is returned to the distributing box and then to the tanks from which it was drawn. Each tank has a slurry mixer supplied with compressed air from a rotary compressor with a capacity of 519 cu. ft. per minute at 40 lb. per square inch.

The Kiln.

The Allis-Chalmers kiln is 11 ft. diameter by 375 ft. long, and is of $\frac{3}{4}$ -in. welded steel plates. It is carried on six tyres riding on rollers and slopes $\frac{3}{8}$ in. per foot. The drive consists of two 75/100-h.p., 400-1200 r.p.m., adjustable-speed, 230-volt motors each connected by rope drive to a gear reducer. A petrol engine is avail-

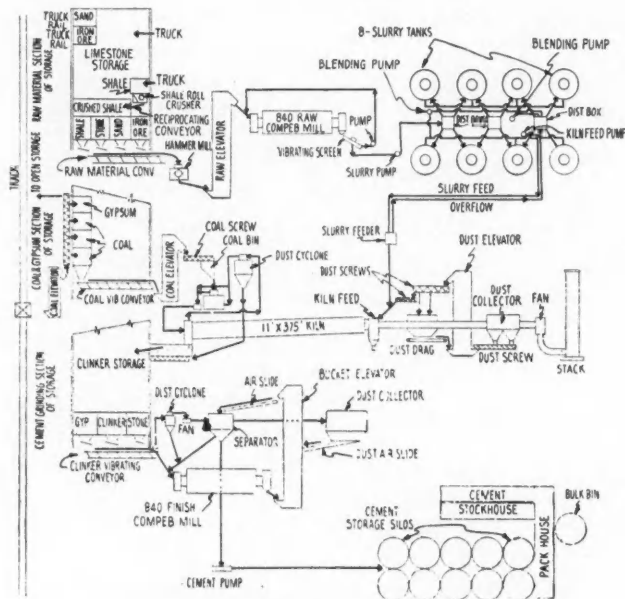


Fig. 3.—Diagram of Wet Process Plant.

able in the event of power failure. The clinker is discharged over a 6-ft. by 33-ft. inclined-grate air-quenching cooler and is cooled to about 125 deg. F. before passing to the pit. Air for cooling is supplied by a fan driven by a 50-h.p. motor. The total volume of air delivered is 35,500 cu. ft. per minute, of which 14,240 cu. ft. are preheated for secondary air delivered to the kiln at a temperature of about 1230 deg. F. and the remainder, at about 250 deg. F., passes to the chimney.

The kiln is fired by a direct-firing coal mill driven by a 200-h.p. squirrel-cage motor. The mill is fed with 1½-in. coal, which is ground to a fineness of 97 per cent, passing a 100-mesh sieve. The coal is delivered by rail and discharged into a track-hopper from which a reciprocating feeder and bucket elevator, with a 16-in. overhead screw-conveyor, conveys it to three 100-tons overhead bins from which it is withdrawn by an 18-in. by 63-ft. oscillating conveyor which carries it to a bucket-elevator from which a 16-in. screw conveyor fills a 100-tons bin. Air for drying the coal is drawn from the kiln hood at the rate of 600 cu. ft. per minute. It passes through a cyclone to trap clinker dust and enters the mill at a temperature of 400 deg. to 500 deg. F. The mixture of air and coal entering the kiln through a 12-in. water-cooled burner-pipe is kept at a temperature of 180 deg. F. by pneumatic or manual manipulation of the cold-air damper in the heated-air pipe.

The gases are drawn through a cyclone-type dust collector and are exhausted by an 84-in., 4-blade, induced-draught fan through a 10-ft. by 150-ft. concrete chimney. The dust-collector and fan have a capacity of 125,000 cu. ft. per minute at 500 deg. F. The fan is driven at 649 r.p.m. by a 250-h.p. motor. All the

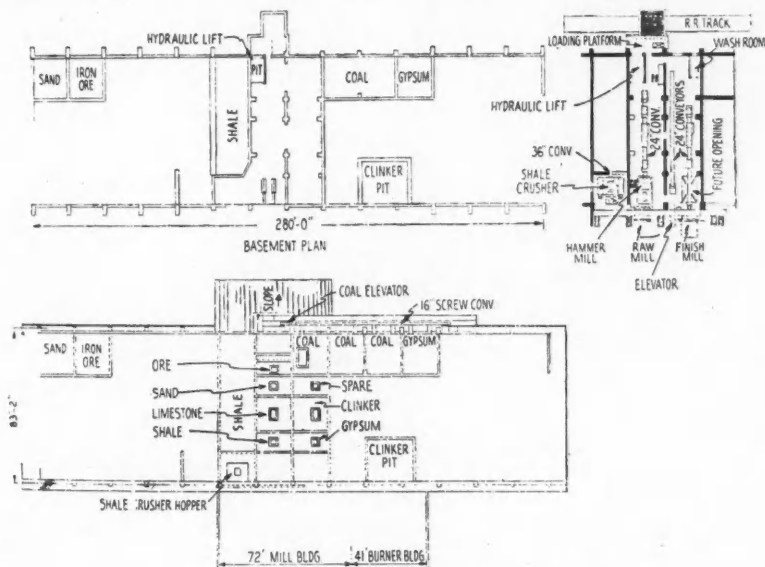


Fig. 4.—Arrangement of Store.

dust is returned to the kiln and mixed with the slurry. Dust from the collector is taken by a 12-in. screw-conveyor to an enclosed-bucket elevator for transfer to a 12-in. horizontal overhead screw-conveyor above a 40-tons bin. A transverse 4-in. screw-conveyor is connected to the 12-in. conveyor to deliver dust from the circulating stream into a vortex mixer where it is mixed with the slurry. The small screw-conveyor has a variable-speed drive to adjust the rate at which the dust is returned to the kiln. Excess dust overflows into a bin from which a drag-chain conveyor transfers it to the dust elevator. Dust can be drawn from this bin for disposal by truck.

All the instruments controlling the firing of the kiln are on a panel on the burner's floor. A meter records the use of coal in lb. per hour; this is done volumetrically through a counter in a spout, 12 in. square, from the coal-feed bin to the bowl-mill. Separate thermocouples below the chain section record the tem-

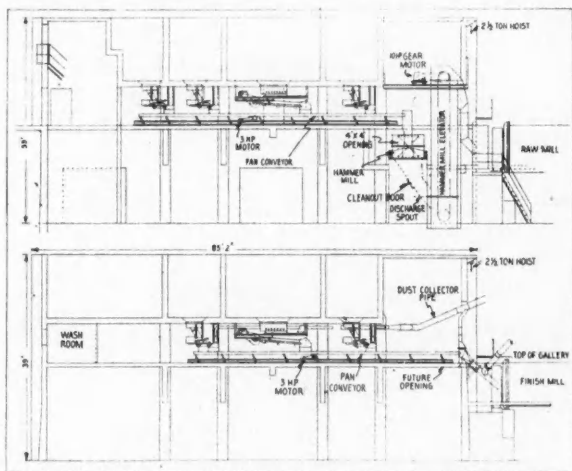
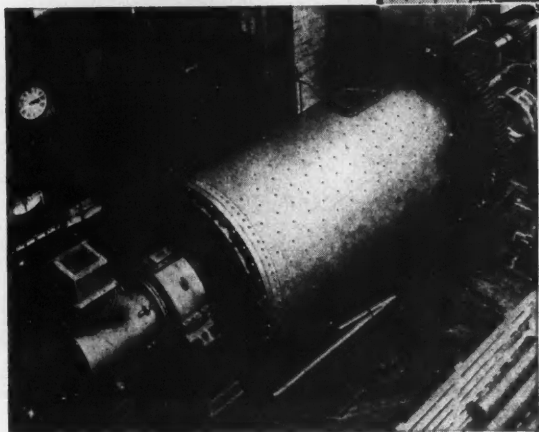
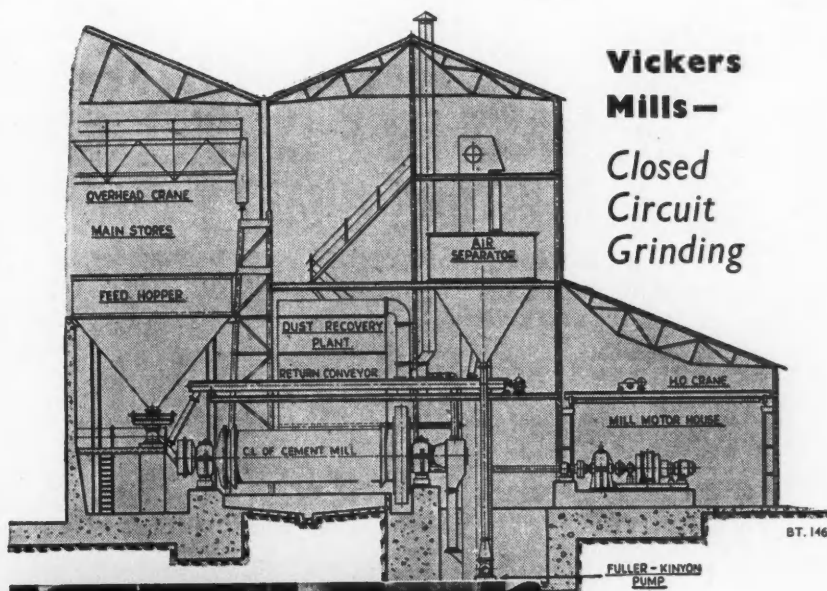


Fig. 5.—Elevation of Feeders and Conveyors for the Raw Mill and Finish Mill.

perature of the gases and of the nodules as they pass the chains. The temperature of the gases at the upper end of the chains is also recorded. The draught is adjusted to keep the temperature of the nodules at about 600 deg. F. when the temperature of the gas at the lower end of the chains is 1250 to 1350 deg. F. Should the temperature of the nodules fall below 600 deg. F. the slurry passing the chains is considered to be too wet and the draught through the kiln is increased, and vice versa. The cooler has manual and automatic grate-speed control for regulating the temperature of the secondary air for combustion. A pipe from the air duct of the cooler supplies air for cooling the kiln nose-ring. A highly volatile coal of 12,500 B.Th.U. per lb. is used and the consumption is about 600 lb. per ton of cement.

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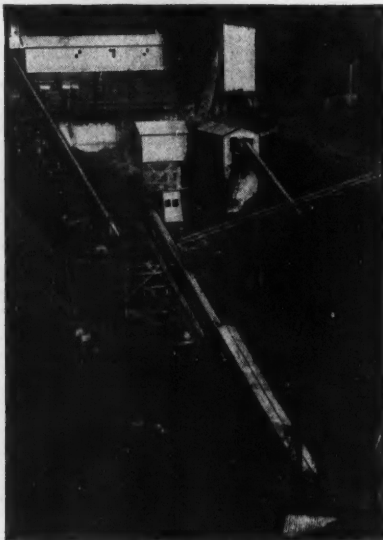
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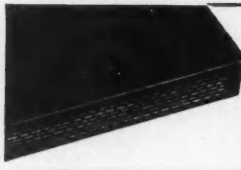
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Finishing Mill.

The size of clinker discharged from the cooler is about 2 in. The clinker is removed from the pit to the store by an overhead crane, which also conveys it to the mill feed-bin. Gypsum is conveyed in a similar manner to a second bin, and the third bin in the row over a common 24-in. by 50-ft. oscillating conveyor is for limestone for the manufacture of masonry cement. The arrangement of the plant is shown in *Fig. 6*. Proportioning is by constant-weight feeders on to the conveyor, which discharges directly into the finishing mill; this is a three-compartment mill identical with the raw mill and carrying a similar charge. It is driven at 18.7 r.p.m. and is operated in closed-circuit with a 16-ft. mechanical air-separator driven by a 75-h.p. motor. The mill stream is elevated and the transfer into the separator is by a 12-in. airstride. Rejects are returned to the mill, and the finished cement is transported to storage by a 6-in. pump. A rotary compressor with a capacity of

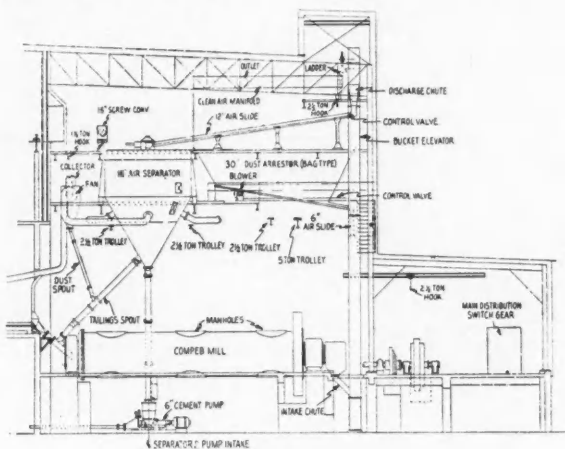


Fig. 6.—Finishing Mill.

585 cu. ft. per minute serves the pump. The capacity of the mill is 20 tons per hour of cement ground to a surface area of 1750 sq. cm. per gramme (Wagner).

Air for cooling is drawn through a separator, which is on the suction side of a 30-ft., 6-compartment, bag-type, automatic dust collector serving the bucket-elevator and the discharge end of the grinding mill. The dust is conveyed by an 8-in. airslide from the collector to the enclosed bucket-elevator. Dust is also drawn from the oscillating conveyor to a cyclone collector which exhausts cleaned air into the mechanical air-separator.

Storage and Packing.

The cement is stored in a rectangular warehouse with a capacity of 4100 tons and in eight reinforced concrete silos with a capacity of 16,600 tons. The packing

equipment consists of a 3-tube machine for the warehouse and two 4-tube packers for the silos. The cement is delivered by rail, about 60 per cent, being delivered loose.

The general design of the plant was by the company's engineering department. Detailed design and the construction were carried out by the Macdonald Engineering Co. The foregoing description is abstracted from "Rock Products" for August, 1953.

New Cement Works for Angola.

PERMISSION has been granted for the erection of a new cement factory near Cuanza, Angola, Portuguese West Africa. The erection is to be supervised by the management of the Secil cement works.

Cement Production in Portugal.

THE production of cement in Portugal in the year 1952 amounted to 727,025 tons, of which about 175,000 tons were exported.

New Cement Plants for Turkey.

THE Emlak Bank is supervising the erection of twelve new cement factories at Afyon Karahisar, Adana, Soke, Bartin, Corum, Canakkale, Erzerum, Laleburgaz, Konya, Diyarbekir, Eskisehir, and Van. Plans for a further five factories are expected to be announced later.

Extensions to Works in Pakistan.

THE Economic Council of Pakistan has approved a scheme for the building of additions to the Wah and Attock cement factories.

Cement Production in Colombia.

THE production of cement in Colombia in the year 1952 was 700,000 tons. This compares with 200,000 tons in the year 1942.

New Cement Works in Venezuela.

WORK has started on the erection of a new cement factory at Chichiriviche, Venezuela. It is expected that the works, which has a capacity of about 45 tons a day, will be in operation early in the year 1955.

New Cement Works in Norway.

THE Nordland cement works at Tysfjord is to be extended to produce 260,000 tons of cement a year instead of 130,000 tons as at present.

New Lime Works in Kenya.

THE construction has started of a new works at Nairobi with a capacity of 500 tons of lime a month, for Lime & Cement Factory (E.A.) Ltd.

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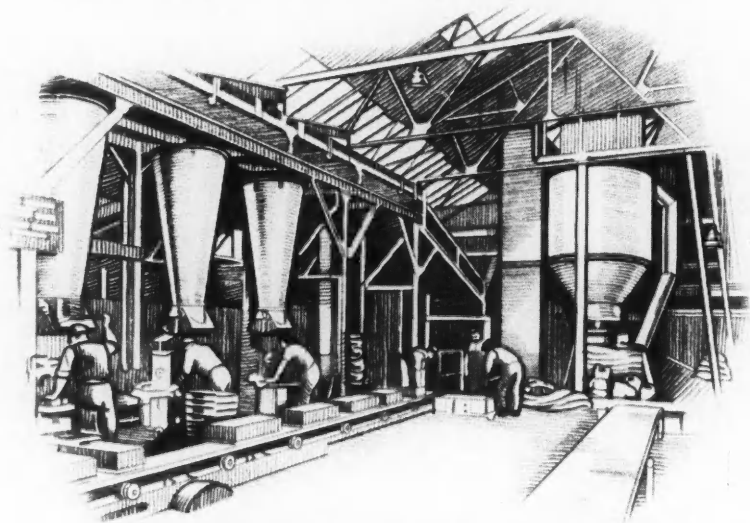
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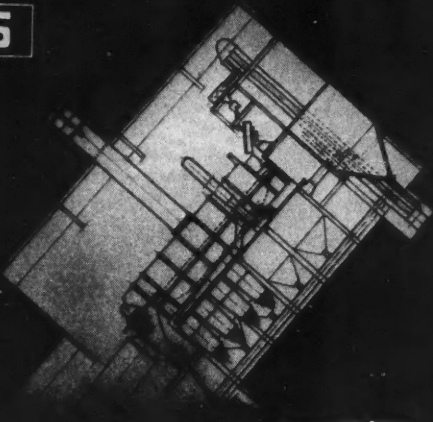
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INDEX TO VOL. XXVI, 1953

	PAGE		PAGE
Angola, New cement works in	46, 88	Hydrophobic cement, by R. W. Nurse, M.Sc., F.Inst.P.	47
AUTHORS:		Kenya, New lime works in	88
Chevrier, M., and M. Houbas on Effect of sulphates on cement and concrete	73	Kiln, An improved Lepol	32
Helming, Bernd, on The Lepol "double-pass" kiln	54	" cement plant in the U.S.A., Single	82
Jaspers, Dr. M. J. M., on Relation between specific surface and other properties of cement	12	" The Lepol "double-pass," by Dipl. Ing. Bernd Helming	54
Miller, P. T. S., on Cement burning in rotary kilns	17	" Shape of the flame in the rotary	45
Newman, Edwin S., and Lansing S. Wells on Heats of hydration and pozzolana content of Portland-pozzolana cements	75	Kilns, Cement burning in rotary, by P. T. S. Miller	17
Nurse, R. W., M.Sc., F.Inst.P., on Hydrophobic cement	47	" Removing clinker rings from	70
Parker, T. W., Ph.D., F.R.I.C., and R. W. Nurse, M.Sc., F.Inst.P., on Specification tests for heat of hydration of cement	1	Laboratory, A Belgian cement	71
Rezola, Julian, on The Portland cement industry in Spain	27	" in the U.S.A., New	80
Ridge, D. J., on Government cement works, Kankesanuray, Ceylon	33	Line, Research on	77
Thomas, R. K., on Methods of determining the rate of settling of hydrated lime slurries	8	" slurries, Methods of determining the rate of settling of hydrated, by R. K. Thomas	8
Belgian cement laboratory	71	Loose cement by ship, Transporting	80
Belgium, The cement industry in	51	" in Sweden, Delivery of	16
Cement and silicate chemistry	26	Mexico, Production of cement in	46
Ceylon, Government cement works, Kankesanuray, by D. J. Ridge	33	" Extensions of a cement works in	61
Chalk crushing and screening plant	57	" The cement industry in	26
Chile, The cement industry in	32	Morocco, Cement industry in French	44
Clinker rings from kilns, Removing	70	Norway, Cement production in	53
Colombia, Cement production in	88	" New cement works in	88
Congo, New works in Belgium	53	Pakistan, The cement industry in	76
Crushing and screening plant, Chalk	57	" New cement works in	11, 88
Denmark, Cement production in	76	Particle-size analysis, Conference on	25
El Salvador, Cement production in	76	Particle Size in Very Fine Powders, The Measurement of, by H. E. Rose (book review)	53
" New cement works in	46	Patent relating to cement manufacture	44
Flame in the rotary kiln, Shape of the	45	Patented method of improving the plasticity of cement	60
Great Britain, Cement production in 1952	25	Peru, New cement works in	46
Greece, The cement industry in	52	Plaster, Research on	77
Haiti, New cement works in	46	Plasticity of cement, A patented method of improving the	60
Heat of hydration of cement, Specification tests for, by T. W. Parker, Ph.D., F.R.I.C., and R. W. Nurse, M.Sc., F.Inst.P.	1	Poland, Cement plant for	76
Heats of hydration and pozzolana content of Portland-pozzolana cements, by Edwin S. Newman and Lansing S. Wells	75	Portugal, Cement production in	88
Hongkong, Consumption of cement in	45	Pozzolana content of Portland-pozzolana cements, Heats of hydration and, by Edwin S. Newman and Lansing S. Wells	75
Hungary, New cement works in	72	Research on cement	26
		" " lime, and plaster	77
		Rhodesia, New kiln for	76
		Screening plant, Chalk crushing and	57
		Settling of hydrated lime slurries, Methods of determining the rate of, by R. K. Thomas	8
		Ship, Transporting loose cement by	80
		Siam, The cement industry in	51
		Slags, Additions of high-magnesia	26
		Slurries, Methods of determining the rate of settling of hydrated lime, by R. K. Thomas	8

INDEX—continued from previous page

	PAGE		PAGE
Spain, New cement works in	32	Tangier, New cement works in	80
The Portland cement industry in, by Julian Rezola	27	Testing cement	77
Specific surface and other properties of cement, Relation between, by Dr. M. J. M. Jaspers... ..	12	Tests for heat of hydration of cement, Specification, by T. W. Parker, Ph.D., F.R.I.C., and R. W. Nurse, M.Sc., F.Inst.P.	1
Specification tests for heat of hydration of cement, by T. W. Parker, Ph.D., F.R.I.C., and R. W. Nurse, M.Sc., F.Inst.P.	1	Transporting loose cement by ship	80
Sulphates on cement and concrete, Effect of, by M. Chevrier and M. Houbas	73	Turkey, Cement industry in	44, 51, 76
Surface and other properties of cement, Relation between specific, by Dr. M. J. M. Jaspers	12	New cement plants for	88
Sweden, Delivery of loose cement in	16	United States, New cement laboratory in	80
Syria, New cement plant for	76	Uganda, New cement works in	11
		Venezuela, New cement works in	88
		Yugoslavia, The cement industry in	51

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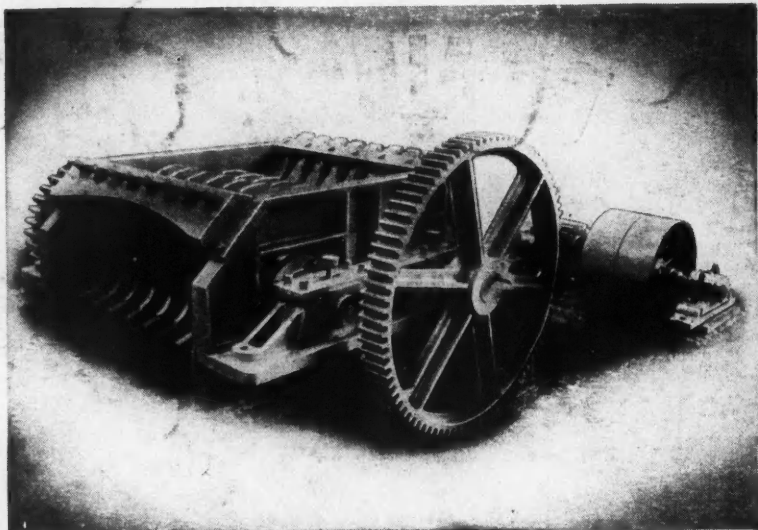


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